MONITORING PLAN

PROJECT NO. T/V-13A
OAKS/AVERY CANAL HYDROLOGIC RESTORATION

March 19, 1999

Project Description

The project area encompasses 2,876 acres (1,164 ha) located in the extreme eastern portion of Vermilion Parish and southwestern portion of Iberia Parish, north of Vermilion Bay (United States Geological Survey 1998)(figure 1). The Vermilion Bay shoreline makes up most of the southern boundary of the project area. The major tributaries and waterways within the project area are Oaks Canal to the west, Avery Canal on the east, and the Gulf Intracoastal Waterway (GIWW) traversing the project area east to west. Union Oil Canal makes up the eastern boundary of the hydrologic unit of the project north of the GIWW. Most soils in this area are classified as Lafitte Muck, which are very poorly drained, very fluid, organic soils in brackish marshes (Natural Resources Conservation Service [NRCS] 1978, 1996). The area is composed of approximately 1,936 acres (783 ha) of brackish marsh and 791 acres (320 ha) of open water, 4.8% of which is dominated by submerged aquatic vegetation (SAV), with the remainder made up of nonmarsh habitats (USGS 1998). The dominant SAV species is *Myriophyllum spicatum* (Eurasian milfoil)(Castellanos 1998). The vegetation in the area has historically been classified as brackish and intermediate marsh (O'Neil 1949, Chabreck and Linscombe 1968, 1978, 1988). Land loss rates in the project area averaged 8 ac/yr from 1956-1978 (USGS 1998). Current erosion rate estimates for the Vermilion Bay shoreline and the GIWW bank in the project area are 13 ft/yr (4 m/yr) and 5 - 10 ft/yr (1.5 - 3 m/yr) respectively (NRCS and Louisiana Department of Natural Resources [LDNR] 1996). Results from the Boston Canal / Vermilion Bay Shoreline Protection Project (TV-09) reference area, which is along the same shoreline as this project, reported an average erosion rate of 5.17 ft/yr (1.58 m/yr) for the period November 1995 to March 1998 (Thibodeaux 1998).

This project consists of the following unrelated restorative components designed to address different land loss problems within the project area: protection of Vermilion Bay shoreline with vegetative plantings; protection of GIWW bankline with rock dikes; stabilization of water level variability north of the GIWW and east of Oaks Canal; and reestablishment of Bayou Petite Anse through Tigre Lagoon. Each problem and the project feature designed to address it are described in the following paragraphs.

The Vermilion Bay shoreline is subject to high energy wind driven waves due to the large fetch of Vermilion Bay. Most of the shoreline within the project area is "scalloped", with sloped banks separated by more seaward points of land with cutbanks. Vegetative plantings provide protection for erosion impacted areas by stabilizing sediment with live root mass and dissipating wave energy with above-ground plant structure (Knutson 1977). The lead federal agency for the project, NRCS, determined that vegetation plantings, similar to those used for the effective TV-09 project (Thibodeaux 1998), are the preferred alternative to protect this shoreline (NRCS 1998). The plantings of this project, along with those of the adjacent TV-09 project will provide approximately

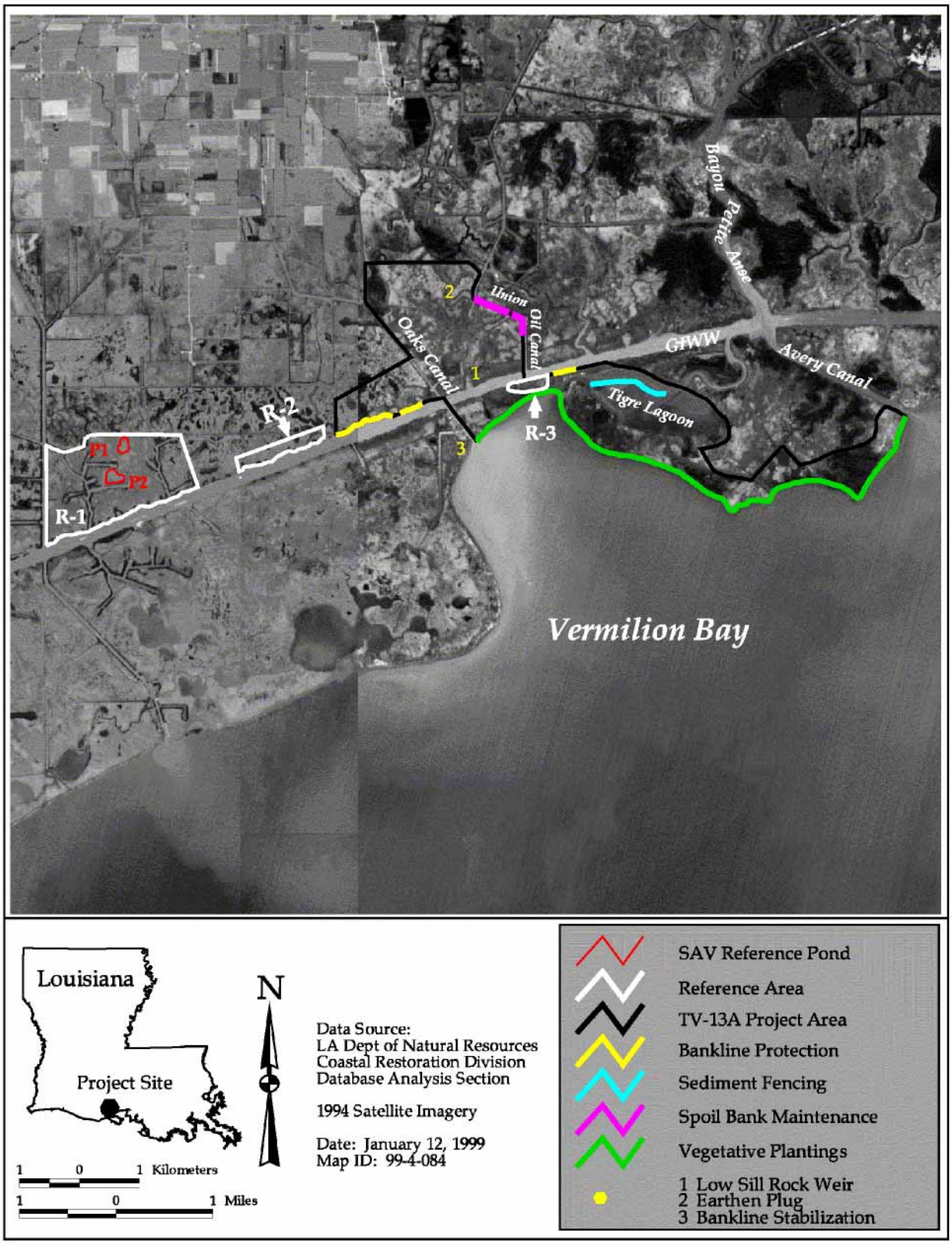

Figure 1 Oaks/Avery Canal Hydrologic Restoration (TV-13a) Project boundary and features and reference areas.

19 miles (30.6 km) of nearly continuous protection for the Vermilion Bay shoreline from Mud Point eastward to Avery Canal.

The banks of the GIWW within the project boundary are subjected to erosion from boat wakes from heavy commercial traffic (Good et al. 1995). The emergent marsh and SAV behind the bank will be subject to the erosive action of boat wakes if the banks are not protected. Wake protection from marine traffic will be provided along sections of the GIWW by freestanding dike sections of riprap material placed approximately 25–30 ft (7.6 - 9.1 m) from the existing "cut" bank. Approximately 1,200 ft (365.8 m) of bankline will be protected on the south embankment in the area where Bayou Petite Anse exits Tigre Lagoon and enters Vermilion Bay (figure 1). The narrow strip of land that currently separates Bayou Petite Anse from the GIWW continues to reduce in size due to the eroding banks of the GIWW. The remaining 4,800 ft (1,463 m) of bankline stabilization is planned for the north bank of the GIWW immediately west of Oaks Canal (figure 1). The absence of spoil bank material in this section of the GIWW exposes fragile marsh soils to the erosive wake action of passing marine vessels.

The section of the project area north of the GIWW and east of Oaks Canal is currently subject to increased effects of tidal action and frontal storm passage, and from water surges created by daily barge traffic in the GIWW. The scour erosion from rapid water movement through channels in the area may physically damage vegetation and cause excess water turbidity, which has been found to be an important factor limiting SAV growth (Korschgen et al. 1997). A low sill rock weir will be set 2 ft below marsh level, approximately 150 ft (45.7 m) north of the opening of this area to the GIWW, to stabilize water levels and lessen the impact of the approximately 500 acres (202 ha) of this section of the project area that will be the hydrologic unit (figure 1). An existing spoilbank from the weir south to the Intracoastal Canal will be refurbished to prevent the possibility of water flow bypassing the structure. To ensure the integrity of the hydrologic unit, a breach between the hydrologic unit and outside waterways will be plugged with earthen fill. Additionally, existing substandard sections of the hydrologic unit embankment south of the earthen plug will be refurbished (figure 1).

Low sill structures being built at the outfall of Oaks and Avery Canals for the TV-13b state project are expected to redirect more water flow through the part of Bayou Petite Anse south of the GIWW. In Tigre Lagoon, along the remnants of the Bayou Petite Anse channel, segmented structures will be installed on the historical south bank of the channel. The segmented structures will reduce surface flows currently entering Tigre Lagoon, encouraging the reestablishment of the Bayou Petite Anse channel and allowing an efficient flow of the expected increased volume of water.

The purpose of the project is to protect existing wetlands, stabilize hydrologic conditions, reestablish Bayou Petite Anse channel through Tigre Lagoon, and encourage the growth of emergent and submergent vegetation. Project features include:

1. Bankline stabilization along the outfall of Oaks Canal

2. Approximately 6,000 ft (1,829 m) of bankline stabilization along the north and south banks of the GIWW

3. A fixed crest rock weir in an artificial channel 1,900 ft (579 m) east of Oaks Canal and 900 ft (274 m) north of the GIWW

4. An earthen plug in an opening through the north embankment of an oilfield canal along the Union Oil Canal in the northeast section of the project area, north of the GIWW

5. Maintenance of approximately 1,000 ft (305 m) of incremental sections of spoil embankment on the western side of the Union Oil Canal

6. Approximately 4,300 ft (1,311 m) of structures along the historic southern channel edge of Bayou Petite Anse inside Tigre Lagoon

7. Approximately 27,000 ft (8,230 m) of vegetative plantings (*Spartina alterniflora* [saltmarsh cordgrass]) along the northern shoreline of Vermilion Bay between Oaks Canal and Avery Canal

Project Objectives

1. Protect the Vermilion Bay shoreline through the planting of *S. alterniflora*

2. Protect sections of the GIWW bank from erosion through use of rock dikes

3. Reestablish Bayou Petite Anse in Tigre Lagoon

4. Stabilize water levels in the hydrologic unit

Specific Goals

The following measurable goals were established to evaluate project effectiveness:

1. Reduce erosion rate on the northern shoreline of Vermilion Bay

2. Reduce erosion rate of specific high-risk portions of the GIWW bank

3. Reestablish the Bayou Petite Anse channel in Tigre Lagoon

4. Attenuate rapid water level fluctuations in hydrologic unit

5. Increase occurrence of SAV north of the GIWW in the project area

6. Reduce marsh loss rates of emergent vegetated marsh area in the hydrologic unit

Reference Area

To assist in evaluating project effectiveness over time, reference areas will be monitored concurrently with the project area. The main criteria for selecting a reference area are similarities in vegetative community, marsh soil type, hydrology, and proximity to the project area. Based on these criteria, reference area one (R1) was selected as a reference for the hydrologic unit for the water level and aerial photography monitoring elements. Ponds within R1 will be SAV references pond 1 (P1) and pond 2 (P2). The ponds are relatively close to the SAV sampling areas, and it shares similar hydrological connections to the GIWW. Two reference areas (R2 and R3) for GIWW shoreline change monitoring element will be established along the bank of the GIWW adjacent to the bank sections protected by the rock breakwater. The bank types of R2 and R3 most closely match those of the respective project areas on the north and south banks of the GIWW (figure 1). An appropriate reference area for the Vermilion shoreline protection was not available. To the west of the project area, the shoreline has been planted as part of the TV-09 project. To the east, the shoreline has already been planted, and it has a different orientation to Vermilion Bay than that of the project area shoreline.

Monitoring Elements

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

1. Aerial Photography — To document land and water acreage and land loss rates in the hydrologic unit, reference area, and whole project area, color infrared aerial photography (1:12,000 scale with ground controls) of the project and reference areas will be obtained. The photography will be georectified by National Wetlands Research Center (NWRC) personnel following procedures described in Steyer et al. (1995), but detailed photo interpretation, mapping, and GIS is not planned. The photography will be obtained in 1999 (preconstruction) and in years 2002, 2006, 2011, 2014, and 2017.

2. Vegetative Plantings — The general condition of *S. alterniflora* plantings along Vermilion Bay will be documented by monitoring twenty-five 40-ft long vegetation sampling plots (3% of entire planted area). Each plot will consist of 16 plantings with the sampling location determined by a random numbers table based on distance and marked with a pole. Species composition, and % cover for the 16 plant plot will be documented using the Braun-Blanquet procedure. Survival will be determined as a percentage of the number of live plants to the number planted

(within the plot) (Mendelssohn et al. 1991). These criteria will be documented at years 2000, 2002, 2004, and a later year to be determined, or until original plants become indistinguishable from each other.

3. Submersed Aquatic Vegetation

The rake method will be used to document changes in the relative frequency of SAV in the project and reference areas (Nyman and Chabreck 1996). At least two transects will be established in three ponds in the hydrologic unit and in two ponds in the selected SAV reference areas. Open water areas will be sampled for presence or absence of SAV along each transect line at 25 to 100 points, depending on the size of the water body. Species composition and relative frequency of occurrence (frequency = [number of occurrences / number of samples taken] x 100) will be determined. Monitoring will be conducted at the peak of the growing season (October) in 1999 (immediately postconstruction) and in years 2000, 2002, 2004, 2006, 2009, 2011, 2014, and 2017.

4. Shoreline Change

The shoreline position will be monitored along Vermilion Bay, along sections of the GIWW bank where rock dikes will be constructed, and along the reference area bankline in R2 and R3. A differential Global Positioning System (GPS) will be used to map the shoreline in 1999 (immediately post-construction) and in years 2002, 2004, 2006, 2009, 2011, 2014, and 2017. The difference between shoreline change in the reference areas and the project will be used to estimate the area of wetlands protected by the rock dikes. Because of the lack of a suitable reference area for the Vermilion Bay shoreline, the benefits of the plantings cannot be directly determined, but they can be inferred from the survival of the plantings.

5. Bathymetric Survey

To document the reestablishment of the Bayou Petite Anse channel in Tigre Lagoon, elevations will be measured along cross sections surveyed across the existing channel remnants by contract engineers. Bathymetry profiles will be taken across the channel at the beginning and end of the structures, and at intervals of at least 500 ft in between, with elevations taken every 10 ft along each profile. Cross sections will extend from the channelization structures across the existing Bayou Petite Anse channel and tie into the vegetated edge of the northern shoreline of Tigre Lagoon. Benchmarks will be installed at the time of construction to ensure the accuracy of subsequent cross section measurements. Surveys will be conducted in 1999

(immediately post-construction) and in 2002, 2004, 2009, 2011, 2014, and 2017.

6. Water Level — To monitor hydrologic conditions (water depth, salinity) and document water levels within the hydrologic unit, one hourly data recorder will be placed inside the unit and three recorders will be placed in R1 at three locations along a semi-natural waterway at increasing distances from the GIWW. Water level data will be used to document the water level variability in the project area relative to R1. Water level data will be collected at the shortest interval possible with the recorders (every 30 seconds) for 10 days each month for the years 1999 through 2009, and years 2011, 2014, and 2017.

Anticipated Statistical Analyses and Hypotheses

The following paragraphs describe the analyses that will be conducted on data collected for the monitoring element listed to evaluate the accomplishment of the project goals. The numbers to the left correspond to the monitoring elements described above. These are followed by statements of the project goals, and the hypotheses that will be used in the evaluation.

1. Aerial Photography:

Descriptive and summary statistics on historical data and data from color-infrared aerial photography collected before and after construction will be used, along with GIS interpretations of these data sets, to evaluate marsh to open water ratios and changes in the rate of marsh loss/gain in the project area.

Goal: Reduce marsh loss rates of emergent vegetated marsh area in the hydrologic unit

Hypothesis:

H_o: Marsh loss rates (over time) of emergent vegetated marsh area will not differ among sites (project and reference) and sampling times (pre- and postconstruction).

H_a: Marsh loss rates (over time) of emergent vegetated marsh area will differ among sites (project and reference) and sampling times (pre- and postconstruction).

Note: If a difference is observed, then the direction of change will be determined.

2. Vegetative Plantings:

The change in percent cover, species composition, and percent survival over time will be analyzed using appropriate parametric and/or nonparametric statistics, descriptive statistics, and life tables. The condition of the plantings will be used to infer the protection afforded to the Vermilion Bay shoreline.

3. SAV:

Appropriate parametric and/or nonparametric statistics will be used to test the following hypothesis.

Goal: Increase occurrence of SAV north of the GIWW in the project area

Hypothesis:

H_o: Mean occurrence of SAV within the project area will not differ among sites (project and reference) and sampling periods (pre- and postconstruction).

H_a: Mean occurrence of SAV within the project area will differ among sites (project and reference) and sampling periods (pre- and postconstruction).

Note: If a difference is observed, then the direction of change will be determined.

4. Shoreline Change:

Appropriate parametric and/or nonparametric statistics will be used to test the following hypothesis.

Goal: Reduce erosion rate on the northern shoreline of Vermilion Bay

Hypothesis:

H_o: Mean erosion rate of the northern shoreline of Vermilion Bay postconstruction will not differ significantly from the erosion rate preconstruction.

H_a: Mean erosion rate of the northern shoreline of Vermilion Bay postconstruction will be significantly lower than the erosion rate preconstruction.

Goal: Reduce erosion rate of specific high-risk portions of the GIWW bank

Hypothesis:

H_o: Mean erosion rate of specific high-risk portions of the GIWW bank will not differ among sites (project and reference) and sampling periods (pre- and postconstruction).

H_a: Mean erosion rate of specific high-risk portions of the GIWW bank will differ among sites (project and reference) and sampling periods (pre- and postconstruction).

Note: If a difference is observed, then the direction of change will be determined.

5. Bathymetric Survey:

Appropriate parametric and/or nonparametric statistics will be used to test the following hypotheses.

Goal: Reestablish the Bayou Petite Anse channel in Tigre Lagoon

Hypothesis:

H_o: The mean cross sectional area of the Bayou Petite Anse channel in Tigre Lagoon will not be greater postconstruction than preconstruction.

H_a: The mean cross sectional area of the Bayou Petite Anse channel in Tigre Lagoon will be greater postconstruction than preconstruction.

6. Water Level:

Appropriate parametric and/or nonparametric statistics will be used to test the following hypotheses.

Goal: Attenuate rapid water level fluctuations in hydrologic unit

Hypothesis:

H_o: Water level variability (measured in terms of standard deviation of water level) in the hydrologic unit will not differ among sites (project and reference) and sampling periods (pre- and postconstruction).

H_a: Water level variability (measured in terms of standard deviation of water level) in the hydrologic unit will differ among sites (project and reference) and sampling periods (pre and postconstruction).

Note: If a difference is observed, then the direction of change will be determined.

NOTE: Available ecological data, including both descriptive and quantitative data, will be evaluated in concert with the statistical analysis of all the above data to aid in determination of the overall project effectiveness. This includes ancillary data collected in the monitoring project but not used directly in statistical analysis, as well as data available from other sources (USACE, USFWS, LSU, DNR, etc.).

Notes

1.	Planned Implementation:	Start construction: End construction:	June 1, 1999 January 1, 2000
2.	NRCS Project Manager	Loland Broussard	(318) 291-3069
3.	DNR Project Manager: DNR Monitoring Manager: DNR DAS Assistant:	Herb Juneau David Castellanos Laura Townley	(318) 893-3643 (318) 893-3352 (504) 342-4122

4. The twenty year monitoring plan development and implementation budget for this project is $673,747. Progress reports will be available in 2000, 2001, 2003, 2004, 2006, 2007, and comprehensive reports will be available in 2002, 2005, 2008, 2012, 2015, and 2019. These reports will describe the status and effectiveness of the project.

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